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IS 590 (1964): Fixed Paper Dielectric Capacitors for DC  
[LITD 5: Semiconductor and Other Electronic Components and  
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“Knowledge is such a treasure which cannot be stolen”



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IS : 590 - 1964

# *Indian Standard*

## **SPECIFICATION FOR FIXED PAPER DIELECTRIC CAPACITORS FOR DC**

*( Revised )*

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**INDIAN STANDARDS INSTITUTION  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002**

# *Indian Standard*

## SPECIFICATION FOR FIXED PAPER DIELECTRIC CAPACITORS FOR DC

### ( Revised )

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# *Indian Standard*

## SPECIFICATION FOR FIXED PAPER DIELECTRIC CAPACITORS FOR DC

### ( Revised )

#### 0. FOREWORD

**0.1** This Indian Standard ( Revised ) was adopted by the Indian Standards Institution on 13 August 1964, after the draft finalized by the Electronic Components Sectional Committee had been approved by the Electrotechnical Division Council.

**0.2** This standard was first published in 1954. Since then a number of Indian Standards covering a variety of electronic components have been published and the work of the International Electrotechnical Commission ( IEC ) has also progressed considerably in this field. In this revision advantage has been taken of all these developments in the past few years.

**0.3** The more important features of this revision are as follows:

- a) The details of mechanical durability test have been deleted after making suitable reference to IS : 589-1961\*.
- b) Since the capacitors covered by this standard are essentially designed for dc operation, this limitation has been clearly indicated in the title. The earlier method of grading of capacitors based on range of operating temperatures has been replaced by introduction of three distinct categories based on climatic durability in line with other component standards.

**0.4** This standard is one of a series of Indian Standards on capacitors used in electronic and telecommunication equipment. Others in the series are:

†IS : 1980-1961 Ceramic Dielectric Capacitors, Type I

IS : 2001-1962 Fixed Silvered Mica Capacitors

**0.5** This standard largely follows the recommendations of the International Electrotechnical Commission as given in IEC Doc : 40 ( Central Office ) 107.

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\*Basic climatic and mechanical durability tests for electronic components ( revised ).

†Since revised.

**0.6** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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## 1. SCOPE

**1.1** This standard covers tests and requirements for fixed capacitors designed essentially for dc with a rated voltage not exceeding 6 300 V, using a dielectric of impregnated paper and electrodes of foil, and intended for use in equipment for telecommunication and similar other electronic devices.

**1.1.1** This standard does not cover metallized paper capacitors nor capacitors used for radio interference suppression.

**1.2** Dimensional requirements of the capacitors are not included in this standard.

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions shall apply.

**2.1 Rated Voltage ( $U_R$ )** — The voltage that can be continuously applied between the terminals of a capacitor at an ambient temperature of 70°C.

**2.2 Category Voltage ( $U_C$ )** — The voltage that can be continuously applied between the terminals of a capacitor at the maximum temperature pertaining to the particular category.

**2.3 Tangent of Loss Angle ( $\tan \delta$ )** — The power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency.

**2.4 Rated Capacitance** — The value of the capacitance marked on the capacitor.

**2.5 Type Tests** — Tests carried out to prove conformity with the requirements of this specification. These are intended to prove the general quality and design of a given type of capacitor.

**2.6 Acceptance Tests** — Tests carried out on samples selected from a lot for the purposes of acceptance of the lot.

**2.7 Routing Tests** — Tests carried out on each capacitor to check the requirements which are likely to vary during production.

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\*Rules for rounding off numerical values (*revised*).



**2.8 Lot** — All capacitors of the same category and rating, manufactured by the same factory, during the same period.

### 3. CATEGORIES

**3.1 Fixed paper dielectric capacitors** shall be of three categories corresponding to the severities of climatic tests as detailed in Table 1.

**TABLE 1 CATEGORIES OF FIXED PAPER DIELECTRIC CAPACITORS**

| CLIMATIC TEST               | SEVERITY           |                   |                     |
|-----------------------------|--------------------|-------------------|---------------------|
|                             | Category 1         | Category 2        | Category 3          |
| (1)                         | (2)                | (3)               | (4)                 |
| Dry heat                    | +100°C             | +85°C             | +70°C               |
| Cold                        | −55°C              | −40°C             | −10°C               |
| Damp heat ( long term )     | 56 days            | 56 days           | 21 days             |
| Damp heat ( accelerated )   | 6 cycles           | 6 cycles          | 2 cycles            |
| Rapid change of temperature | +100°C to<br>−55°C | +85°C to<br>−40°C | Not appli-<br>cable |
| Low air pressure            | 44 mbar            | 300 mbar          | 600 mbar            |

NOTE — In case of special requirements where the above categories cannot be strictly applied, different combinations of severities may be agreed to between the purchaser and the manufacturer provided such degrees of severity are chosen from IS : 589-1961\*.

### 4. RATINGS

**4.1 Rated Capacitances and Tolerances** — The values of rated capacitance and their associated tolerances shall preferably be in conformity with IS : 824-1956†.

**4.2 Rated Voltage** — The standard values of rated voltages for the capacitors shall be:

40, 50, 63, 100, 160, 250, 400, 500, 630, 1 000, 1 500, 1 600, 2 500, 4 000 and 6 300 V dc.

NOTE — The values given above except 500 and 1 500 are preferred and are from the basic series R5 of preferred numbers included in ISO/R 3-1953‡.

**4.2.1** In the case of capacitors intended to be applied on dc only, the working voltage is the dc voltage applied to the terminals. Where alternating voltages are present in addition to dc voltage, the working voltage

\*Basic climatic and mechanical durability tests for electronic components ( revised ).

†Series of preferred values for capacitors and resistors ( since revised ).

‡Preferred numbers.

of the capacitor shall be taken as the sum of the dc voltage and the peak alternating voltage. This sum shall not exceed the value of the rated voltage. The value of the peak alternating voltage at each of the following frequencies shall not exceed the percentage of rated voltage specified below for the corresponding frequency:

| <i>Frequency</i> | <i>Percent</i> |
|------------------|----------------|
| 50 c/s           | 20             |
| 100 c/s          | 15             |
| 1 000 c/s        | 3              |
| 10 000 c/s       | 1              |

## 5. CONSTRUCTION AND WORKMANSHIP

### 5.1 Construction

**5.1.1 Terminals** — Unless otherwise specified, the terminals of the capacitors shall be either in the shape of screws, tags or wires and so coated as to be easily solderable ( *see 12* for soldering test ). Each wire terminal shall be at least 38 mm long and of diameter between 0.5 and 1.00 mm.

**5.2 Workmanship** — All parts shall be manufactured in a thoroughly workmanlike manner and in accordance with the best current practice.

## 6. MARKING

**6.1** The capacitors shall be provided with the following information:

- a) Rated capacitance in microfarads or pico farads,
- b) Rated voltage (  $U_R$  ),
- c) Category voltage (  $U_C$  ),
- d) Indication of the connection to the outer foil ( in the case of tubular capacitors only ),

*NOTE* — This indication shall be made by a heavy type arrowhead pointing towards the outside foil termination or by any other suitable means.

- e) Tolerance on capacitance value,
- f) Manufacturer's name or trade-mark,
- g) Indication of category according to this standard,
- h) Week ( or month ) and year of manufacture ( this may be in code ), and
- j) Any other marking, if agreed to between the manufacturer and the purchaser.

*NOTE 1* — The temperature shall be mentioned in the case of rated voltage (  $U_R$  ) and category voltage (  $U_C$  ).

*NOTE 2* — In the case of Category 3 capacitors, separate mention of  $U_C$  may be omitted as it will be the same as  $U_R$ .

**6.2** The capacitor shall be clearly marked with items (a), (b) and (c) of 6.1 and with as many as possible of the remaining items in the order of preference indicated, as agreed to between the manufacturer and the purchaser.

**6.3** The package containing the capacitor(s) shall be clearly marked with all the items specified in 6.1.

**6.4** The markings shall be such as not to become illegible during service through reasonable handling and while in storage. A transparent protective coat or other suitable means may be used to ensure this.

**6.5** The capacitors may also be marked with the ISI Certification Mark.

**NOTE** — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

## **7. GENERAL CONDITIONS FOR TESTS**

**7.1 Selection of Samples** — The samples for tests shall be so selected as to be representative of the range of capacitance value, voltage rating and category of the type under consideration.

**7.2 Standard Atmospheric Conditions for Tests** — Unless otherwise specified, tests shall be carried out under standard atmospheric conditions for testing as specified in IS : 589-1961\*.

**7.3 Preconditioning** — Before measurements are made, the capacitors shall be stored at the measuring temperature and relative humidity for sufficient time to allow the entire capacitor to reach these conditions. The recovery period called for after climatic conditioning is adequate for this purpose.

**7.4 Correction to be Applied** — When measurements are made at a temperature other than the reference temperature ( *see* IS : 589-1961\* ) the result shall, wherever necessary, be corrected to the reference temperature. The ambient temperature during the tests shall be stated in the test report.

**7.5 Drying** — Where drying before measurement is required, it shall be carried out in accordance with clause 4.5 of IS : 589-1961\*.

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\*Basic climatic and mechanical durability tests for electronic components ( *revised* ).

## **8. CLASSIFICATION OF TESTS**

### **8.1 Type Tests — ( see 2.5 ).**

**8.1.1 Type Approval Procedure** — The procedure for type approval shall be in accordance with IS : 2612-1965\*.

**8.1.2 Number of Samples and Sequence of Type Tests** — The manufacturer shall submit 34 samples of capacitors of each category and size equally divided between:

- a) maximum capacitance at its highest rated voltage, and
- b) maximum rated voltage at its highest capacitance.

Out of the 34 samples, two shall be kept as spare and the balance used for type tests in accordance with the sequence given in Appendix A.

**NOTE** — The storage tests shall not be considered for issue of type approval certificate.

### **8.2 Acceptance Tests**

**8.2.1** The following shall comprise acceptance tests to be carried out in the sequence indicated below on samples for the purpose of acceptance of a lot:

- a) Visual examination and dimensions,
- b) Robustness of terminations,
- c) Soldering,
- d) Capacitance value,
- e) Tangent of loss angle,
- f) Insulation resistance,
- g) Outer foil marking, and
- h) Climatic sequence.

**8.2.1.1** A proportion of the samples shall be broken open and internally examined for any signs of deterioration or defects.

**8.2.2 Sampling Procedure** — The sampling procedure for acceptance of lots shall be agreed to between the purchaser and the supplier. In the absence of such an agreement, the procedure laid down in IS : 2612-1965\* is recommended.

### **8.3 Routine Tests**

**8.3.1** The following tests shall be carried out on each and every capacitor:

- a) Visual examination and dimensions,
- b) Capacitance,
- c) Voltage proof ( as a flash test ), and
- d) Insulation resistance.

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\*Recommendation for type approval and sampling procedures for electronic components.

## 9. ELECTRICAL TESTS

### 9.1 Capacitance

**9.1.1** The capacitance shall be measured at or corrected to measurements made at a frequency of 800 to 1 200 c/s in the case of capacitors whose nominal capacitance value does not exceed  $1\mu\text{F}$  and the rated voltage does not exceed 3 000 V. Capacitors of all other values and voltage ratings shall be measured at a frequency of 40 to 60 c/s.

**9.1.2** The measuring method shall be such that the error does not exceed:

- a) ten percent of the rated capacitance tolerance for absolute capacitance measurements, and
- b) ten percent of the specified maximum change of capacitance for measurements of variation of capacitance.

The applied voltage shall not exceed the limits specified in 4.2.1.

**9.1.3** The capacitance value shall correspond with the rated capacitance taking into account the rated tolerance or any other limit laid down in the relevant test in this standard.

### 9.2 Tangent of Loss Angle

**9.2.1** When measured under conditions specified in 9.1 with an instrument accurate to 0.001, the tangent of loss angle shall not exceed 0.01.

### 9.3 Voltage Proof

**9.3.1** The capacitors shall withstand, without breakdown or flashover, the following test.

**9.3.2** A dc test voltage of the values specified below shall be applied under conditions specified in 7.2 for a period of one minute:

- a) For single section capacitors:
  - 1) Between terminations  $2.5 U_R$
  - 2) Between terminations connected together and case  $2.5 U_R$  with a minimum of 200 V
- b) For multiple section capacitors having a common termination for all sections:
  - 1) Between each termination and the common termination  $2.5 U_R$
  - 2) Between all terminations connected together and the case  $2.5 U_R$  with a minimum of 200 V
  - 3) Between the non-common termination of each section and all the other terminations connected together  $2.5 U_R$  with a minimum of 200 V

c) For multiple-section capacitors having no common termination:

- |   |                                   |
|---|-----------------------------------|
| 1) Between the terminations of each section   | $2.5 U_R$                         |
| 2) Between all terminations connected together and the case   | $2.5 U_R$ with a minimum of 200 V |
| 3) Between the terminations of separate sections, the two terminations of each section being connected together | $2.5 U_R$ with a minimum of 200 V |

**9.3.2.1** For capacitors of rated voltage higher than 5 000 V dc, the test voltage shall be  $2 U_R$  instead of  $2.5 U_R$ .

**9.3.3** The circuit for this test shall be so chosen that the voltage is applied immediately through the internal resistance of the test apparatus. The product of this internal resistance and the rated capacitance value of the capacitor under test plus any parallel capacitance in the test apparatus shall not exceed one second. The charging current shall not exceed one ampere.

**9.3.4** A suitable circuit for this test is given in Appendix B.

**9.3.5** Where the case of the capacitor is non-metallic or where the capacitor has a metallic case with an insulating sleeve, the capacitor shall be mounted in its normal position on a metal plate, which extends at least 12.5 mm beyond the mounting face of the capacitor in all directions; the test voltage shall be applied between the terminations connected together and the metal plate.

**9.3.6** When this test is conducted as a routine or acceptance test, the voltage shall be applied for one second only.

**9.3.7** After the test, the capacitors shall be kept short-circuited for at least 24 hours.

## **9.4 Insulation Resistance**

**9.4.1** Measurement of insulation resistance shall be made (a) between terminals, (b) between terminals short-circuited and the case, if the case is metallic, and (c) between terminals short-circuited and a metal mounting plate, if the case is non-metallic. In the case of (c), the mounting plate shall project at least 12.5 mm beyond the edge of the face with which it is in contact.

**9.4.2** The dc voltages for measurement of insulation resistance shall be

as follows corresponding to the rated voltages:

| <i><b>Rated Voltage</b></i> | <i><b>dc Test Voltage</b></i>  |
|-----------------------------|--------------------------------|
| Up to and including 100 V   | Rated voltage $\pm 15$ percent |
| Above 100 V and below 500 V | 100 $\pm 15$ V                 |
| 500 V and above             | 500 $\pm 50$ V                 |

**9.4.3** The dc voltage shall be applied for one minute  $\pm 5$  seconds. The voltage shall not be applied gradually but at once through the internal resistance of the test apparatus. The product of this internal resistance in ohms and the rated capacitance in farads shall not exceed one second. Before measurement of the insulation resistance, the capacitor shall be fully discharged.

**9.4.4 Multiple Section Capacitors** — In the case of multiple section capacitors having a common termination for all sections, the insulation resistance shall be measured (a) between each of the terminals and the common terminal, and (b) between all terminals connected together and the case or mounting plate, as the case may be. In the case of multiple section capacitors having no common terminal, the insulation resistance shall be measured (a) between terminals of each section, (b) between the terminals of separate sections, the two terminals of each section being connected together, and (c) between all terminals connected together and the case or mounting plate.

**9.4.5** The insulation resistance value of different categories of capacitors shall be not less than the values specified below at the reference temperature specified in IS : 589-1961\*

|  | <i><b>Minimum Insulation Resistance</b></i>  |
|--|--|
| Categories 1 and 2 ( between terminals ) | 5 000 divided by the nominal capacitance in microfarads or 25 000 megohms, whichever is less |
| Category 3 ( between terminals )         | 2 000 divided by nominal capacitance in microfarads or 10 000 megohms, whichever is less     |

All three categories

- a) Capacitors in metallic containers, capacitor terminals connected together and the case 1 000 megohms
- b) Capacitors in metallic containers enclosed in or covered with an insulating material between container and mounting plate 1 000 megohms

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\*Basic climatic and mechanical durability tests for electronic components ( revised ).

**IS : 590 - 1964**

- c) Capacitors in non-metallic containers between capacitor terminals connected together and the mounting plate 5 000 megohms

**9.4.6 Correction Factors** — The insulation resistance value shall, if necessary, be corrected by multiplying the result of measurement by the appropriate correction factor chosen from the values given below:

| <i>Temperature<br/>°C</i> | <i>Correction Factor</i> |
|---------------------------|--------------------------|
| 15                        | 0.71                     |
| 16                        | 0.76                     |
| 17                        | 0.81                     |
| 18                        | 0.87                     |
| 19                        | 0.93                     |
| 20                        | 1.00                     |
| 21                        | 1.07                     |
| 22                        | 1.15                     |
| 23                        | 1.23                     |
| 24                        | 1.32                     |
| 25                        | 1.41                     |
| 26                        | 1.52                     |
| 27                        | 1.62                     |
| 28                        | 1.74                     |
| 29                        | 1.87                     |
| 30                        | 2.00                     |
| 31                        | 2.14                     |
| 32                        | 2.30                     |
| 33                        | 2.46                     |
| 34                        | 2.64                     |
| 35                        | 2.83                     |

**9.4.7** In case of doubt about accuracy of the correction factor, the value at 20°C shall prevail.

**9.5 Inductance Test ( for Tubular Capacitors Only )**

**9.5.1** The inductance of the capacitor shall not be greater than that of a wire 0.20 mm in diameter and of a length equal to that of the capacitor



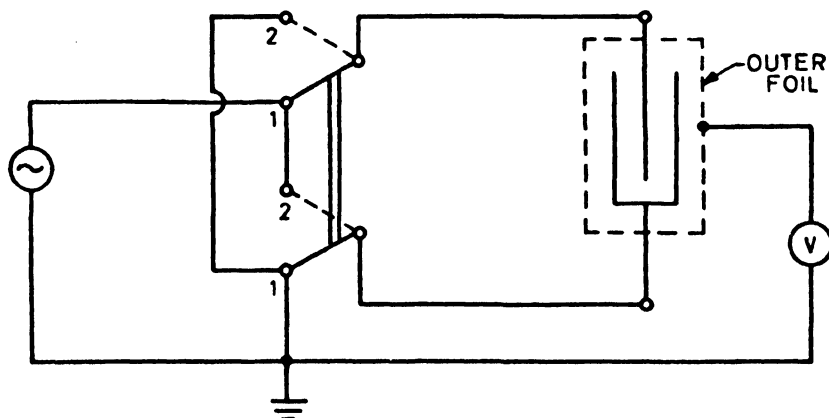
plus the minimum amount of lead required to connect the capacitor to the test apparatus. The total length of the connecting lead shall not exceed the length of the body of the capacitor.

**9.5.2** The frequency at which the comparison is made shall be such that the inductive reactance measured shall be not less than 10 times the capacitance reactance.

**9.5.3** The inductance of the capacitor shall not be greater than the inductance of the wire.

## **9.6 Test for Outer Foil Indication ( for Tubular Capacitors Only )**

**9.6.1** The correct indication of the termination which is connected to the outside metal foil shall be checked in such a way that the capacitor is not damaged. A suitable method is shown in Fig. 1.



**FIG. 1 ARRANGEMENT FOR CHECKING OUTER FOIL INDICATION**

**9.6.2** With the switch in position 1, the deflection of the voltmeter shall be markedly less than with the switch in position 2.

**9.6.3** The frequency of the ac generator may be from 50 c/s to a few thousand cycles per second and shall be so chosen as to give a clear result of the measurement, the most appropriate value being dependent on the type of capacitor under test. The voltage shall be of the order of 10 V. The voltmeter shall have input impedance of approximately one megohm or higher.

**9.6.4** In the case of metal encased capacitors, the outer metal case shall be connected to the voltmeter. In the case of moulded type capacitors, an external metal foil shall be wrapped for this purpose.

## 10. VISUAL EXAMINATION AND DIMENSIONS

**10.1** The capacitors shall be visually examined for compliance with marking and workmanship.

**10.2** The dimensions shall be checked and shall comply with those specified.

## 11. ROBUSTNESS OF TERMINATIONS

**11.1 Tensile Test on Terminations** — This test shall be carried out in accordance with 7.19.1 of IS : 589-1961\*, the loading weight being 2.0 kg.

**NOTE** — The body of the capacitor shall be claimed in such a way that the coating, if any, of the capacitor does not peel off during the test.

### 11.2 Bending Test on Terminations

**11.2.1 Wire Terminations** — The bending test on wire terminations shall be carried out in accordance with 7.19.2.2 of IS : 589-1961\*. Care shall be taken to ensure that the bend occurs at a point 6 mm away from the point of emergence of the wire from the capacitor and around a radius of 0.75 mm. A suitable arrangement to ensure this requirement is shown in Fig. 2. Each termination shall withstand two consecutive bends without visible damage to the capacitor.

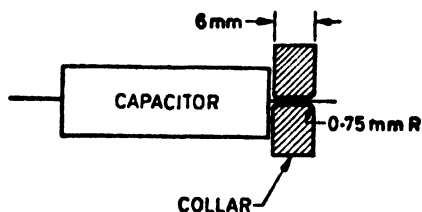


FIG. 2 ARRANGEMENT FOR BEND TEST

**11.2.2 Tag Terminations** — The bending test on tag type terminations shall be carried out in accordance with 7.19.2.3 of IS : 589-1961\*. Each soldering tag shall withstand two consecutive cycles of bending without visible damage to the capacitor.

## 12. SOLDERING TEST

**12.1** The capacitor shall be dried ( see 7.5 ), and the values of capacitance and tangent of loss angle measured.

\* Basic climatic and mechanical durability tests for electronic components ( revised ).

**12.2** The capacitor shall be subjected to the solder-bath test in accordance with 7.18.2 of IS : 589-1961\*.

**NOTE** — For capacitors with tag terminals, the soldering iron test in accordance with 7.18.3 of IS : 589-1961\* may be applied in cases where the solder-bath test is not practicable.

**12.3** The capacitor shall be visually examined and there shall be no apparent damage.

**12.4** The capacitance and tangent of loss angle shall be measured between  $\frac{1}{2}$  hour and one hour after immersion in the solder-bath.

**12.5** There shall be no change in capacitance compared with the value measured in 12.1 and there shall be no change in the value of tangent of loss angle.

### **13. VIBRATION TEST**

**13.1** The capacitors shall be subjected to the vibration ( fatigue ) test in accordance with 7.6.6 of IS : 589-1961\* for severity 3.

**13.2** The capacitors shall be mounted in accordance with 7.6.4.1 of IS : 589-1961\* taking care that the terminal wires are not stressed and in such a manner that equal numbers are vibrated along each of the three principal axes.

**13.3** The capacitors shall then be visually examined and there shall be no apparent damage or any mechanical deterioration.

**13.4** There shall be no change in capacitance value. The tangent of loss angle shall not have changed.

### **14. BUMP TEST**

**14.1** The capacitors shall be subjected to the bump test in accordance with 7.5.1 of IS : 589-1961\*.

**14.2** The capacitors shall be mounted as specified in 13.2 and in such a manner that equal numbers are bumped along the three principal axes.

**14.3** The capacitors shall then be visually examined and there shall be no apparent damage or any mechanical deterioration.

**14.4** There shall be no change in capacitance. The tangent of loss angle shall not have changed.

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\*Basic climatic and mechanical durability tests for electronic components ( revised ).

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## **15. CLIMATIC SEQUENCE**

### **15.1 Dry Heat Test**

**15.1.1** The capacitors shall be subjected to dry heat test in accordance with 7.2 of IS : 589-1961\*.

**15.1.2** The temperature of the test chamber shall be maintained at the maximum temperature relevant to the category.

In the last one hour of exposure to dry heat conditions, the insulation resistance and tangent of loss angle shall be measured. They shall not exceed specified values. ( The values are under consideration. )

**15.1.3** After recovery, the capacitors shall be visually examined. There shall be no apparent damage or seepage of impregnant.

**15.1.4** The capacitance, tangent of loss angle and insulation resistance shall again be measured.

**15.1.5** The change in capacitance, when compared with the value measured in 9.1, shall not exceed 5 percent.

### **15.2 Damp Heat ( Accelerated ) Test, First Cycle**

**15.2.1** The capacitors shall be subjected to the first cycle of damp heat ( accelerated ) test in accordance with 7.4 of IS : 589-1961\*.

**15.2.2** The duration of the recovery shall be one and a half hours.

**15.2.3** After recovery, the capacitors shall be immediately subjected to the cold test.

### **15.3 Cold Test**

**15.3.1** The capacitors shall be subjected to the cold test in accordance with 7.1 of IS : 589-1961\*.

**15.3.2** The temperature of the test chamber shall be maintained at the lowest category temperature and the duration of the exposure shall be one and a half hours. The capacitance value shall be measured while the capacitors are still in the cold chamber.

**15.3.3** The capacitors shall be removed from the cold chamber and visually examined. There shall be no apparent damage. The markings shall be legible and indelible. The capacitors shall remain under recovery conditions for 2 to 4 hours. They shall then be removed from the chamber and shaken by hand to remove droplets of water.

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\*Basic climatic and mechanical durability tests for electronic components ( revised ).

### 15.4 Low Air-Pressure Test

**15.4.1** The capacitors shall be subjected to the low air-pressure test in accordance with 7.12 of IS : 589-1961\*.

**15.4.2** The test chamber shall be maintained at an air pressure appropriate to the category and a temperature range of 15° to 35°C. The duration of the exposure shall be one hour.

**15.4.3** While still at the specified low pressure, and during the last 5 minutes of the one-hour period of conditioning, a dc test voltage equal to  $1\frac{1}{2}$  times the rated voltage shall be applied to the terminals of the capacitor.

**NOTE** — When the capacitor has a metallic case, half the lot of capacitors shall have the voltage applied between terminals connected and the metallic case.

**15.4.4** During and after this test, the capacitors shall be visually examined. There shall be no deformation of the case or seepage of impregnant and no sign of breakdown or flashover.

### 15.5 Damp Heat ( Accelerated ) Test, Remaining Cycles

**15.5.1** The capacitors shall be subjected to the remaining cycles of damp heat ( accelerated ) test in accordance with 7.4 of IS : 589-1961\*. The number of cycles shall be appropriate to the category. Within 15 minutes after removal from the chamber, the rated voltage shall be applied to the capacitors.

**15.5.2** After recovery, the capacitors shall be visually examined. There shall be no apparent damage and the markings shall be legible.

**15.5.3** The capacitance value shall not have changed from the value measured in 9.1 by more than  $7\frac{1}{2}$  percent. The insulation resistance shall meet the following requirements:

|                               |  |   |
|-------------------------------|--|---|
| Category 1                    | } No change in value compared with 9.1 |   |
| Category 2                    |  |   |
| Category 3                    |  |   |
| a) Between terminals          |  | 1 000 divided by nominal capacitance in $\mu\text{F}$ or 5 000 megohms, whichever is less |
| b) Terminals to case or plate |  | Not less than 1 000 megohms   |
| c) Case to plate              |  | Not less than 1 000 megohms   |

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\*Basic climatic and mechanical durability tests for electronic components ( revised ).

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|  |                             |
|--|-----------------------------|
| d) Terminals to mounting plate ( for non-metallic containers ) | Not less than 2 500 megohms |
|--|-----------------------------|

### **16. DAMP HEAT ( LONG TERM EXPOSURE ) TEST**

**16.1** The capacitors shall be subjected to this test in accordance with 7.3 of IS : 589-1961\*, the duration of the conditioning being appropriate to the category. Within 15 minutes of removal from the chamber, the rated voltage shall be applied to the capacitors.

**16.2** After recovery, the capacitors shall be visually examined. There shall be no apparent damage and the markings shall be legible.

**16.3** The capacitance value shall not have changed from that measured in 9.1 by more than 5 percent.

**16.4** The tangent of loss angle shall not have varied. The insulation resistance shall not have changed by more than the values specified in 9.4.

### **17. SALT MIST TEST**

**17.1** The capacitors shall be subjected to the salt mist test in accordance with 7.10 of IS : 589-1961\*. The duration of the exposure shall be 4 days.

**17.2** The capacitors shall be visually examined and there shall be no apparent damage and the markings shall be legible.

### **18. STORAGE ( NORMAL ) TEST**

**18.1** The capacitors shall be subjected to storage in accordance with 7.8.1 of IS : 589-1961\*.

**18.2** After storage for the specified periods, the capacitance, tangent of loss angle and insulation resistance values shall be measured. The values shall not have changed beyond the limits specified. ( The values are under consideration. )

### **19. RAPID CHANGE OF TEMPERATURE TEST ( APPLICABLE TO CATEGORIES 1 AND 2 ONLY )**

**19.1** The capacitance shall be measured.

**19.2** The capacitors shall be subjected to one cycle of rapid change of temperature test in accordance with 7.14 of IS : 589-1961\*.

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\*Basic climatic and mechanical durability tests for electronic components ( revised ).

**19.3** The upper and lower temperature shall be the appropriate maximum and minimum category temperatures respectively.

**19.4** After recovery, the capacitors shall be visually examined. There shall be no apparent damage.

**19.5** The capacitors shall be subjected to the voltage proof test in accordance with **9.3**.

**19.6** The capacitance of the capacitors shall again be measured. The change of capacitance shall not exceed 5 percent.

## **20. MOULD GROWTH TEST**

**20.1** The capacitors shall be subjected to the mould growth test in accordance with **7.9** of IS : 589-1961\* and shall satisfy the requirements laid down therein.

## **21. ENDURANCE TEST**

**21.1** The capacitance, tangent of loss angle and insulation resistance values shall be measured.

**21.2** The capacitors shall be subjected to an endurance test at the rated dc voltage for 1 000 hours in an atmosphere maintained at the maximum category temperature.

**21.3** The capacitors shall be placed in the test chamber in such a manner that no capacitor is within 25 mm from any other capacitor.

**21.4** The capacitors shall not be heated by direct radiation and the circulation of the air in the chamber shall be adequate to prevent the temperature from departing by more than  $\pm 3$  deg C from the specified temperature at any point where the capacitors are placed.

**21.5** It shall be assumed in this test that the temperature of the capacitor is the same as the specified temperature.

**21.6** The voltage shall be applied to the capacitors individually through a resistor whose value is approximately 1 ohm per volt.

**21.7** The capacitor shall be deemed to have failed if a temporary or permanent short-circuit occurs in the capacitor or between any electrode and the case.

**21.8** After the specified period, the capacitors shall be allowed to come back to standard atmospheric conditions.

**21.9** They shall then be subjected to two cycles of damp heat ( accelerated ) test as specified in **15.2**.

**21.10** The capacitors shall then be visually examined. There shall be no apparent damage and the markings shall be legible.

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\*Basic climatic and mechanical durability tests for electronic components ( revised ).

**21.11** The capacitance, tangent of loss angle and insulation resistance shall be measured again.

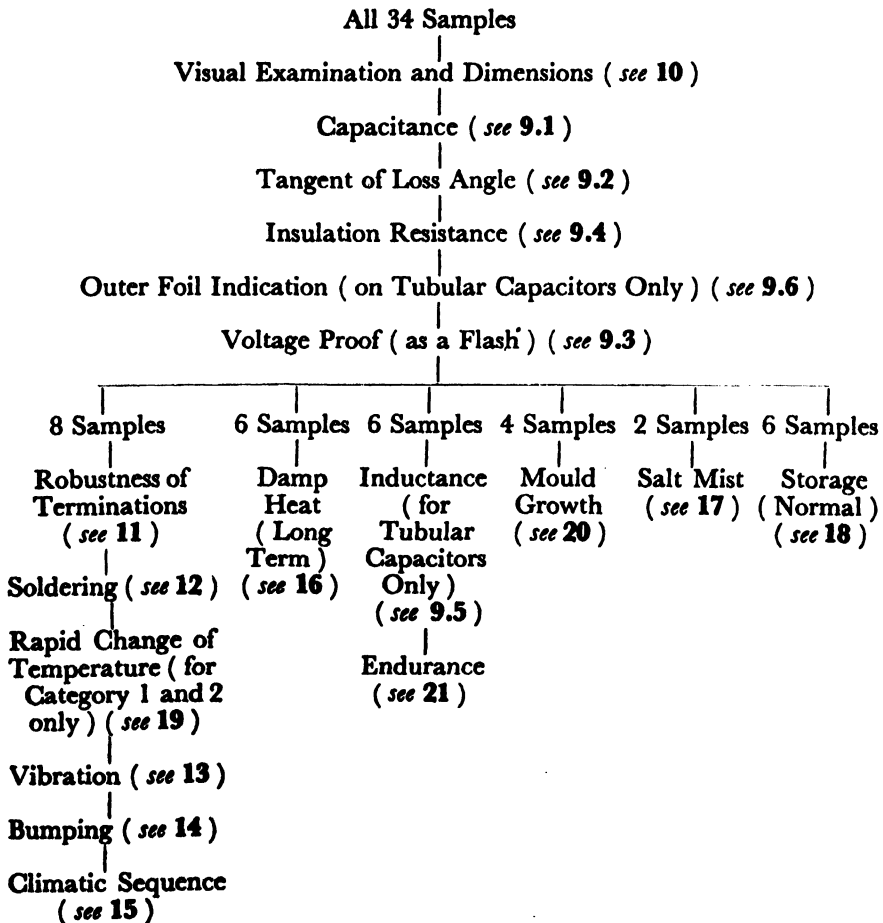
**21.11.1** The change in capacitance as compared with the value measured in 21.1 shall not exceed  $7\frac{1}{2}$  percent.

**21.12** The tangent of loss angle and insulation resistance values shall not have changed from those obtained in 21.1.

## **A P P E N D I X   A**

*( Clause 8.1.2 )*

### **SEQUENCE OF TYPE TESTS**





## APPENDIX B

### ( Clause 9.3.4 )

#### CIRCUIT FOR VOLTAGE PROOF TEST

##### B-1. CIRCUIT

**B-1.1** A suitable circuit for the voltage proof test is shown in Fig. 3.

**B-1.1.1** The resistance of the voltmeter shall be not less than 10 000 ohms per volt.

**B-1.1.2** The value of capacitance  $C_1$  shall be at least 10 times that of  $C_x$ .

**B-1.1.3** The values of resistors  $R_1$  and  $R_2$  shall be such that the initial charging and discharging current does not exceed 50 mA at the highest test voltage. Further,  $R_1$  and  $R_2$  shall have values such that:

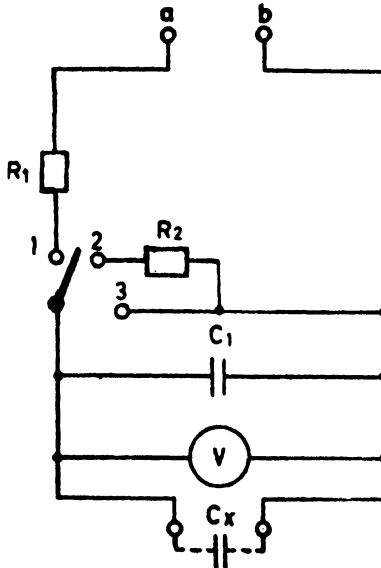
$$R_1 (C_1 + C_x) \leq 1.0$$

$$R_2 (C_1 + C_x) \leq 1.0$$

where

$C_1$  and  $C_x$  are in farads and  $R_1$  and  $R_2$  in ohms.

NOTE —  $R_1$  includes the internal resistance of the power supply.



**FIG. 3 SUITABLE CIRCUIT FOR THE VOLTAGE PROOF TEST**

**B-2. PROCEDURE**

**B-2.1** The switch shall be first connected to  $R_2$ . The two terminals  $a$  and  $b$  shall be connected to a variable dc supply of adequate power which shall be adjusted to the required test voltage.

**B-2.2** The switch shall then be connected to  $R_1$  so that the capacitors  $C_1$  and  $C_2$  are charged.

**B-2.3** The switch shall remain in this position for the period specified in 9.3 after the test voltage has been reached. The capacitor shall then be discharged by connecting the switch to  $R_2$ .

**B-2.4** As soon as the voltmeter reading has fallen to zero, the capacitors shall be short-circuited and  $C_2$  shall be disconnected.

# INTERNATIONAL SYSTEM OF UNITS ( SI UNITS)

## Base Units

| QUANTITY                  | UNIT     | SYMBOL |
|---------------------------|----------|--------|
| Length                    | metre    | m      |
| Mass                      | kilogram | kg     |
| Time                      | second   | s      |
| Electric current          | ampere   | A      |
| Thermodynamic temperature | kelvin   | K      |
| Luminous intensity        | candela  | cd     |
| Amount of substance       | mole     | mol    |

## Supplementary Units

| QUANTITY    | UNIT      | SYMBOL |
|-------------|-----------|--------|
| Plane angle | radian    | rad    |
| Solid angle | steradian | sr     |

## Derived Units

| QUANTITY             | UNIT    | SYMBOL | DEFINITION                      |
|----------------------|---------|--------|---------------------------------|
| Force                | newton  | N      | 1 N = 1 kg.m/s <sup>2</sup>     |
| Energy               | joule   | J      | 1 J = 1 N.m                     |
| Power                | watt    | W      | 1 W = 1 J/s                     |
| Flux                 | weber   | Wb     | 1 Wb = 1 V.s                    |
| Flux density         | tesla   | T      | 1 T = 1 Wb/m <sup>2</sup>       |
| Frequency            | hertz   | Hz     | 1 Hz = 1 c/s (s <sup>-1</sup> ) |
| Electric conductance | siemens | S      | 1 S = 1 A/V                     |
| Electromotive force  | volt    | V      | 1 V = 1 W/A                     |
| Pressure, stress     | pascal  | Pa     | 1 Pa = 1 N/m <sup>2</sup>       |

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